Comments on "Considerations for Refinement of Dissolved Oxygen Criteria: Mount Hope Bay and Taunton River Estuary." Prepared for Massachusetts Department of Environmental Protection" by TetraTech, Inc.

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This is a competently produced document assembling a lot of data and methodological detail needed to develop DO criteria using the approach outlined in the Virginian Province Document (Environmental Protection Agency, 2000), referred to as the Virginian Province Approach (VPA) and also referencing some of the newer adaptations and applications, such as the Chesapeake Bay Approach (Batiuk et al., 2009). I think that this document could lead to a satisfactory understanding of habitat utilization by marine and freshwater species as it impacts application of the Virginian Province Approach to these waters in Massachusetts. Specifically, the document does address what DO levels are needed to protect resident species. Seeing this application of EPA (2000), which has been applied broadly, I did not focus as much on that as on several other issues.

As is the case with DO criteria development in many states, the document does not do as good a job addressing spatial and temporal variability in Dissolved Oxygen as it relates to development and specification of DO criteria levels and treatment of frequency and duration of exposure to DO levels that may cause harm to marine species. In addition, the document does not address how attainment could be assessed and how this relates to known patterns of variability in DO levels in estuaries. In my view, inadequate treatment of spatial and temporal variability can lead to insufficient protection of designated uses.

I made these suggestions recognizing that these same shortcomings are or may be present in the DO standards of other states and the supporting technical basis. However, there is now an improved understanding of DO patterns in estuaries, and improved data to describe it. This new "best available science" provides a pathway to improved DO criteria that would lead to both better resource protection and less potential to focus on DO conditions that are not a concern. Within reason, Massachusetts could make a greater effort to reflect this new science in their rationale for DO criteria.

Seasonal DO criteria

The VP approach is applied to seasonal habitat use data to develop seasonal DO criteria. Because the most sensitive taxa are apparently not present in the winter, the resulting numbers for winter are lower than the values for other seasons (e.g., page viii). There is nothing wrong with this except perhaps that it's probably not important and therefore introduces unneeded complexity into the criteria and scientific rationale. DO concentrations will be higher in the winter than in summer, and it's very unlikely that winter DO will ever be anywhere close to 2.3 mg/L.

Perhaps more important is the application to spring criteria. The CMC for spring was set at 3.3 mg/L which is 0.1 mg/L higher than the summer value. But, the concentration-based criteria in the test data (Environmental Protection Agency, 2000) are based on summer water temperatures, I believe (can be easily checked). In the spring, the water temperature may be much lower, such that in percent saturation terms, the 3.3 mg/L may be LESS protective than 3.2 mg/L in summer. This is a significant concern that should be evaluated. Like the winter criteria, I think that it's also less likely that DO will violate this level without also violating criteria during summer to an even greater extent. In Chesapeake Bay, much further south, DO still doesn't decline strongly until late spring (Hagy et al., 2004). I'm sure that similar data to describe this seasonal dynamic is available for Narragansett Bay. These data should be reviewed and presented as part of the technical support for any seasonal DO criteria.

Natural Background Conditions

At several points, the document introduces the concept of the "natural background conditions". For example, the document notes that the current MA surface water quality standard specifies that "DO shall not be lower than 6.0 mg/L" and then "Where natural background conditions are lower, DO shall not be less than natural background." I do not find any conceptual or quantitative definition within the document of the natural background condition. This leaves a substantial hole in any potential DO criteria, wherein almost any violation may be deemed "natural" and the standard and technical support is silent on the issue. I see this as a major problem. Any exemption for "natural conditions" should either specify what the natural condition is or a procedure for evaluating if a non-attainment is the result of a natural condition. I will note that many other states have a similar exemption. Though potentially justified (i.e., there are instances where DO may be natural prone to decline), the exception need not be encompassing of any possible non-attainment. There is an additional statement on page 50 (and 64): "Low dissolved oxygen condition can natural occur in the deep sections of this [benthic] habitat." This statement is similarly not supported by any evidence or reference. How do we know that low DO is a natural feature of the benthic habitat, and further, if some low DO was naturally present, are we certain that it hasn't become much more common or severe? On page 62, there is a statement that the Chesapeake Bay approach provides values "related to naturally attainable DO conditions." This is only somewhat true. There is an understanding that deep waters in Chesapeake Bay have a different aquatic life use than near-surface waters based on ecological function and very long-term data sets (including cores describing prehistoric conditions). But I do not believe that Chesapeake Bay's use zones have been related specifically to "naturally attainable conditions." The document should provide sufficient definitions if the term "natural" or similarly if the word "attainable" (in the sense of a UAA) is used. As far as I know, there is no requirement that water quality criteria be the same as "natural" or that ALL aquatic life uses in the natural condition be encompassed in the designated uses. Designated uses can be defined within legally defensible bounds, then WQS developed based on a scientific rationale to support those uses. I have even heard designated uses be established that are not practically attainable in the near term, and WQS derived associated with such uses, then variances be established to reflect conditions that cannot be met in the near term (see Montana and Wisconsin, I believe). These could be useful approaches to addressing the question of "natural."

Reference Condition Approach

A reference condition approach is often used when complex water quality conditions may make it difficult to develop a rationale for effects based criteria. There are some well-known challenges with reference conditions as well.

This section notes that "a critical piece of this approach is having data from sites that are minimally affected by anthropogenic influences." This is a real problem for coastal environments with centuries of human alteration of the watershed. I don't see how any part of the Narragansett Bay system could be a reference. Also problematic is the fact that DO conditions are closely linked to physical processes. Other sites, even within the same system, may not be good proxies for what should or could be expected in any particular location in Narragansett Bay. This is not to say that we couldn't utilize existing distributions from systems that are considered healthy, but other information should be applied to experts to relate this to expectations for a different location.

In section 3.2.1 there is a statement that "the chronic objective could be based on the central tendency of the distribution of the DO [reference] data." The rationale is simply that others have done this. It would be better to explain the rationale used by others, and why it applies here. As written, this is entirely without justification.

Further, this section states that the reference condition approach provides for "explicit consideration of what is naturally achievable in terms of DO concentration/saturation for a particular system." This also requires explanation. True, an ideal reference site, one that is "natural" could so this. However, there aren't "natural sites" and the correlation with the physical oceanography affecting DO in Narragansett Bay requires explanation and justification.

Also, there is a statement that "thresholds of percentiles for acute and chronic criteria may be viewed as subjective." I would say that there is no relationship between a reference site percentile and thresholds for acute and chronic criteria, where are effects based rather than reference based. This association would not be "subjective," I think it is arbitrary.

This is not to say that a reference approach has no merit at all. EPA continues to present this as a useful approach. However, care should be taken honestly reflect the limits of such a rationale in the criteria and associated documentation.

Physical Drivers of DO variations

Fluctuations in DO are mostly presented as a seasonally and perhaps spatially varying random process. But, we know a lot more about what drives DO, and this is critical for understanding the implications of the data. Figure 10 on page 14 shows period episodes of low DO at the Cole buoy during September 2016. By referencing tide data from NOAA, I could see that the low periods are, as commonly occurs, associated with reduced tidal mixing resulting from the neap tide. This accounts for the fortnightly recurrence. There are only 3 low periods but they are each associated with the neap tide. The increasing minimum DO is likely tied to the waning of summer and likely decreasing water temperature. The same pattern is apparent, though less prominent, in the data from the Taunton Buy. Comparing the data from the Cole and Taunton buoy, you'll see that the DO minima are synchronous,

because they are linked to the tidal amplitude. The same pattern has been extensively reported in the York River in Virginia (Haas, 1977).

Where this is important is when the results are tabulated as is done in Table 2 on page 15. The % of total days could be interpreted as a relative risk of this occurring, as if it were a random process. But instead it might be a periodic and more certain occurrence tied predictably to trophic status and nutrient loading. On page 74, the document notes that low DO concentrations occur near the bottom for "short periods in the warmer months." This also implies that these are short and random, when they are not random.

How we deal with this in a regulation is not immediately obvious. However, there is a risk in my mind in not addressing it at all. For example, if there is an interest in avoiding having DO impairments and possible regulatory consequences, those who understand this could ensure that monitoring takes place during spring tides. This points to a need to "harmonize" criteria and assessment procedures to ensure adequate resource protection.

Aesthetic Value

I am heartened to see statements like "These waters shall have excellent aesthetic value" as reflected in the State's designated uses and elsewhere. I think that this is an important part of meeting the public expectation for the waters. With respect to DO criteria I emphasize only one point and that is that the WQ requirements for achieving "excellent" or "consistently good" aesthetic value may be higher than for achieving DO that doesn't kill fish or other sensitive marine resources and may require lower TN or TP loads or concentrations. Low DO is (increasingly) easy to measure and therefore tempting as an endpoint for nutrient criteria. Excellent aesthetic value may be harder to measure, but very meaningful and important to the public and equally tied to the ecosystem services or public "benefits" of good water quality.

Continuous DO Monitoring Technology

The document does not mention the make or model of DO sensors used (e.g., on page 11). It should at least mention the type of technology that was used (polarographic or optical, for example). Those who work with these sensors usually want to know because data quality may hinge on it.

"Historic" Conditions

On page 14, the second paragraph begins with "Historically, Atlantic Sturgeon were known to spawn in the Taunton River," then goes on to cite survey observations from 1991 and 1992. Referring to 1991 and 1992 as "historical" is a classic example of the "shifting baselines problem" (Pauly, 1995). My understanding is that existing uses at the time the CWA was passed must be maintained, so perhaps that time frame is useful for defining historical. However, human occupation and alteration of the watershed of Narragansett Bay watershed has a much longer history (Hamburg et al., 2008; Nixon, 1997). Care should be taken to avoid unsupportable statements that imply that the earliest relatively easy to find data defines the historical condition. The state can defensibly set designated uses that are below the historical condition, but should be clear that this is what is being done.

Habitat Definition

Unless I missed it, I'm not sure what the rationale is for defining the "benthic habitat" as the 1 meter of water directly above the bottom and bottom sediments. Does the oxycline follow the bottom terrain in this way? Often it does not, such that there should be plenty of shallower benthic habitat with a much higher DO expectation.

Assessment Procedures

On page 72 there is a note that RI adopted a CCC of 4.8 mg/L that should not be exceeded more than once every three years, except as naturally occurs." I'm wondering, is there an annual time-scale statistic such as the average that can't be exceeded? This is a CCC (i.e., Chronic criteria), not acute. Important details appear to be omitted. I have no doubt that the RI policy includes "except as naturally occurs." As I've noted elsewhere, I fear this permits almost anything because we don't know precisely enough what naturally occurs and what does not occur naturally.

Species references

On page 8, there is a reference to "American oysters." I had only heard of "Eastern Oysters," but I was able to confirm that these are two common names for the same species, *Crassostrea virginica*. Earlier in the same paragraph, the documents refers to "Eastern Oysters." It's important to refer to species by scientific names when important to clarify the taxa in question. Common names one name should be used throughout.

References

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